Economic Impact of the Hybrid Screening in the Print Runs of Offset Sheet

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Abstract

In the past two years, it seems offset printing companies have found in hybrid screening (XM) an alternative for the conventional screening as they gather the advantages of the AM screen and the FM screen. XM is characterized by the layout of the screening dots in a staccato way on the highlights and shadows, keeping a high conventional screen ruling in the halftones. Thereby, it combines the FM screening high definition appearing in the most critical area of image with the softness for the conventional screening halftones. Among other advantages, we can highlight the capacity of printing with high-resolution ruling which avoids difficulties related to reproduction, process control, or the plate-dot maintenance during the printing stage associated to the conventional screen.

Apart from these features and in comparison with the AM screen, this study's outcome highlights the reduction of ink for the hybrid screen. The two kinds of screens being compared in the test are: hybrid screen (21 micron for the smaller dot in the light, and 240 lpi for halftones) and AM screen (175 lpi), both of them being printed onto a 115 g/m^2 coated paper. In order to come to this result, the starting point was a test of a minute selection of images. The layout has been set up for offering the same visual outcome, two of them being hybrid and the two others conventional. Once the work was printed and dried onto the paper, the next step was to cut it with extreme accuracy and carry out the weight of the test piece. These data were recorded.

The outcomes imply an outstanding ink consumption savings which impacts favorably on the economic parameter of the run and involve other advantages such as a reduction in the setoff powder so that this avoids a loss of the ink gloss and makes the subsequent handling of the sheet easier. The risk of ink setoff and ink drying timing decreases so that it allows one to print the other side and handle the job sooner. In this way the process's timing is shorter. In these crisis times, the hybrid screening could be an important ally to the printing companies.

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Preface and Sources Review

Since the beginning of the last century, screening systems based on the conventional amplitude modulation (AM from here on) have constantly been used. The first frequency modulation screening studies (FM, from here on) go back to the mid-’60s, and the first film digital filming machine (imagesetter) was released at the beginning of the ’90s. In this first FM screening generation some problems occurred when transferring the dot from film to plate so that it did not perform well in the market and it was necessary to wait for the release of the computer-to-plate (CTP) technology. This technology allows the correct dot reproduction on the plate by means of a laser.

Using CTP, the dot transfer is no longer a problem so that the manufacturers focus their efforts on improving the quality of the printed product. Then new screening studies arose among which we can highlight the hybrid screening (XM, from here on) and the cross-modulation (Agfa-Gevaert N.V, 2003). This kind of reproduction is intended to be adapted properly to the smallest reproducible dot in printing and to highlight the halftone image with screening up to 340 lpi. The new screening technology gathers the best qualities of the previous one (AM and FM).

There are many manufacturers who have hybrid screening. Besides, all of them agree that the reproduction of the image details is higher than the one they can get with other kind of screening so that the reproduction of the light of image turns out to be especially bright as it is materialized through the stochastic. However, halftones are printed with the conventional screening at high line screen in order to obtain a good smooth effect, especially for pastel colors such as for the human skin or for transition tones used as background. This avoids, in most of the cases, the moiré effect from happening, and if it shows up, it will be subtle. Another evidence of quality is the absence of granulated effect on the halftones, mainly plain colors, which appears frequently on the mere stochastic screening.

On the shadow area as well, the XM screenings have some advantages: they reproduce a higher detail in the most critical dot percentage as they use the FM screening instead of the AM. All of this can be feasible thanks to this kind of screening which allows to copy with no problem at all color ranges from 1 to 99%. The results prove the reproduction levels come to the continuous tone.

The Lisi and Baitz (2006) studies proved the use of frequency modulation screening reduced the ink consumption during printing by 22%. We found it very interesting comparing the ink consumption of the hybrid screening and the conventional one (AM). For this, a test with similar specifications to the one from the authors mentioned above was set up, taking note of all the parameters which could interfere in the process.

The current paper, due to its nature, has been carried out as experimental scientific research, which pretends to solve a problem of a scientific nature using a specific methodology. We agree with Fernandez Nogales (1997) that the meaning of research clearly specifies that the collection of information follows a reliable process which is organized in different stages. This process has been summed up in the following chart:

1. **ESTABLISHMENT OF GOALS**
   Problem approach
   Need of information
   Objectives of research

2. **LITERATURE REVIEW**
   Secondary Sources
   Primary Sources

3. **EXPERIMENT DESIGN FOR OBTAINING PRIMARY INFORMATION**
   Design of the technique

4. **DATA COLLECTION**
   Sampling
   Field Work

5. **DATA ANALYSIS**
   Information processing
   Result of Analysis Techniques

6. **CONCLUSIONS**
   Conclusions
   Report development

Chart 1. *Methodological Process of Scientific Research, Fernandez Nogales (1997).*

To sum up, we agree with Hernandez, Fernandez, and Baptista (1991) that experimental research "is a kind of study where one or more independent variables (alleged causes) are intentionally manipulated so that the consequences of this manipulation on one or more dependent variables (alleged effects) can be submitted to analysis within a control situation for the researcher."

Research Objectives

- The main objective of this research is to quantify the reduction of ink costs when using hybrid screening (XM) compared to conventional screening (AM) in the production process in offset printing companies. The results will have to be quantifiable and shown in kilograms by number of printed copies, having taken into account of the machine format and printed paper.
- Secondary objectives are:
  - To check the true stability of the XM screening
  - To compare visually the printing result of conventional screening images with the same images printed with hybrid screening.
  - To find and assess the variables which usually affect the graphic production process in a conventional printing company.

Research Methodology

a. Printing test production

The method developed to carry out this research involves the creation of a printing test which compares the images that are screened with XM and AM. For this, the images were selected carefully according to a series of requirements to fulfill the objectives set out. The following chart lists them:

SELECTED IMAGES SPECIFICATIONS
- Images with high ink coverage.
- Images which are difficult to color match and reproduce: the ones which hold big quantities of cyan, magenta, and yellow, such as brown colors.
- Images and screening with grey elements which guarantee the achievement of grey balance on the whole print run.
- Images with mixed secondary colors, reds, greens, and blues, which allow distinguishing if there are differences due to the ink trapping.
- Images with areas with high level of details
- Images where the human skin colors are brought out.
- Vignettes.
- Screened patch which allows carrying out additional measurement on the printed sheet.

Chart 2. *Selected images settings.*

Having taken note of all of these requirements, the images which are part of this paper were laid out as a printing test. The layout and significance of them are being listed in the figure below:

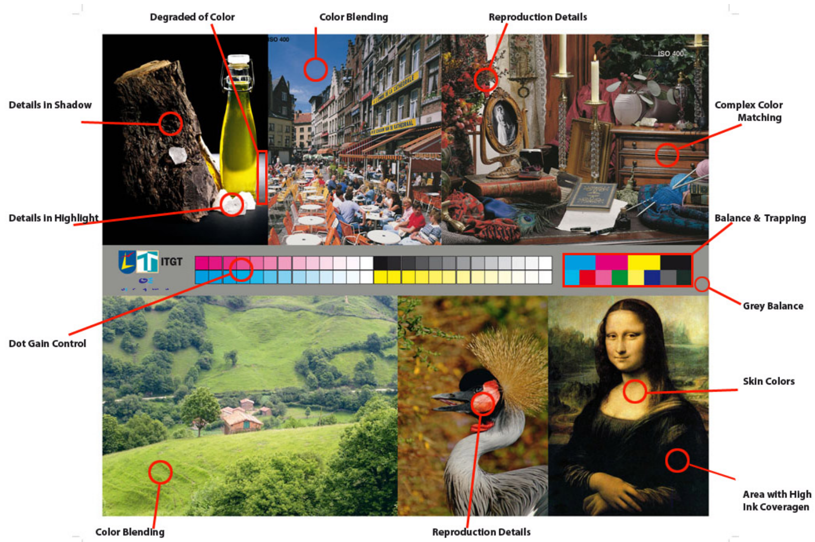

Image 1. *Test images.*

Some of these images belong to the ITGT (Instituto Tecnológico y Gráfico Tajamar), some others are from the Institute's collaborators, and two of them belong to the ISO 12640-1:1997 Standard. As you can see, all of them need a high ink quantity to be printed so that the measurement error in each weight process of the printing sheets will be toned down.

The disposal of the created test onto the plate layout is extremely important so that no problem arises during the printing. The composition of images measures 45×35,7 cm (17,7×14,1 inches) and was imposed for being printed in a Mitsubishi machine, 4 colors, format 5G 96×132 cm (37,8×52 inches). As a result of this, 4 forms were disposed onto the plate (Image 4) and some area was left to insert a control bar, an ink discharge bar for each color, and whites of 1,5 cm (0,59 inch) on the edges of each form. The tests are imposed in a crossed way, facing out the AM and XM screenings, in order to prevent printing problems.

The AGFA SUBLIMA was selected, XM screening with a line screen of 240 lpi and a minimum size dot of 21 microns so that the visual appearance of AM screening of 175 lpi would be as close as possible to the hybrid one.

The trim lines of each proof were not placed at the edges of the proof: as already mentioned, margins of 1.5 cm (0.9 inches) were left to prevent subsequent issues from happening during the cutting process. If the trim lines had been set up on the edges, or on the bleeds, the minimum sheet displacement in the trimmer would have affected the final weight of the test pieces. As a result of this, the final trim size of the work was 103,1×91,6 cm. (40,6×36,1 inches), having worked with the Kodak Preps 5.2. Imposition software for the layout on the plate (Image 2):

Image 2. *Printed forms with AM screening (175 lpi) and XM screening (240 lpi) set up diagonally.*

b. Variables selection

In addition to the selected images specifications showed on Chart 2, we also take into account the requirements on research carried out by Lisi and Baitz (2006). In the chart below, the variables which could distort, if we did not take account of, are listed as follows:

VARIABLES WHICH COULD DISTORT THE RESULTS

Design and prepress

- Images with the specifications stated on Table 2.
- Plates from the same batch, filmed on the same output device, processed on the same device (CTP) and at the same time.
- CTP and proofs devices calibrated.
- The characterization of the printing curve has to be looked after so that we can obtain results which can be compared visually.
- The RIP used for rasterizing the hard proofs and plates will be the same.

Paper specifications

- Depending on the paper trim from the root web, there can be some thickness and bulk variations if the paper is cut in the middle or edges of the reel.
- To achieve the objectives set, the paper smoothness is very important.
- The absolute paper moisture content does affect its weight.
- The paper colorimetry does affect the color of the printed images.

Ink specifications

- The ink which has to be used has to be the same for all the tests performed. This will guarantee that the quantity of solvent, ink drying, and performance in the machine is the same.

Printing variables

- Dot definition: the test has to combine highlight areas, halftones, and shadows to verify the quality of the printed dot.
- Inking zones: the ink quantity can vary from zones to others depending on the ink key settings.
- A lower quantity of ink in the edge of the sheet is possible
- Dampening solution: it does affect the printed paper weight.

- Ink discharge areas: they have to be placed at the input of each pair of samples. Those positions are interesting as the roller train has plenty of ink.
- Setoff: any kind of setoff could affect the sheet weight.
- Antisetoff powder: they can make the paper sheet heavier.
- Color sequence: it does affect the ink layer thickness and the trapping.
- Printing speed: it should be the same so that the tack and the trapping will be affected in the same way.
- Quality of the printing tests: the AM printed images should be equivalent to XM ones and have the same visual appearance.

Other variables

- The color and density measurements take place in the same sheet area and at the same time.
- The weight measurements should be carried out with the same balance, at the same time and place.
- The image cropping should be done with the same sequence and in the same device so that the final test piece weight will not be affected.

Chart 3. *Variables which can affect the results.*
Modified based on Lisi and Baitz research (2006).

c. Device linearization

Once the variables which can affect the research have been listed, we go on with a detailed description of the methodological process.

Once the images had been selected, all RGB images were turned into CMYK images in Adobe® Photoshop® using the profile ISO Coated v2 (ECI). The images were then laid out in Adobe® InDesign®, and a PDF/X-1a:2001 file was created using the ISO Coated v2 (ECI) output profile.

Before starting the task, the CTP was checked. In order to achieve this, a plate from the batch assigned to this research was filmed at 175 lpi and its linearity was checked using the RIP based on PDF Print Engine incorporated in the AGFA workflow. And a plate reader X-Rite Plate Scope® was used as a measurement device. Once the relevant adjustments were made, a second plate was filmed and the dot percentage was amended. The process was rerun for SUBLIMA 240 lpi. The data recorded are shown in the chart below:

Linearity 175 lpi													
Data	0	5	10	20	30	40	50	60	70	80	90	95	100
Measured	0	6.5	12	23	34	42.5	55	63	73	82	92	94	100
Amended	0	4,5	10	20	29	40	49.5	60	69	79	90	94	100

Linearity XM 240 lpi													
Data	0	5	10	20	30	40	50	60	70	80	90	95	100
Measured	0	7	13	23	33.5	43	54	62	73	82	91	93	100
Amended	0	4,5	10.5	20	30	39	49.5	60	69	79	89	94	100

Chart 4. *Plate linearity process.*

d. Colorimetry setup and gain: first test printing

Once the plates were linearized for both screening methods through an AGFA APOGEEX workflow, the production process began exposing positive thermal plate Lastra LT2 for 830 nm to a resolution of 2400 dpi, in a platesetter AGFA Xcalibur VLF 7. For both linearization to be on the same plate, the system DQS (Digital Quick Step), from Agfa, was used. This allows the use of different pages in the same layout.

In order to guarantee the same visual appearance in the screening, a first printing took place. The aim was to know exactly the colorimetry and the dot gain when printing on a matte coated paper of 115 gsm/m^2 (Creator Gloss, 90,5×102 cm, from Torras Papel). The characterization curve was not modified, that is, linear variables were filmed: 50% on the document versus 50% on the plate. During the printing process, the inking was regulated according to ISO 12647-2 standard specifications. Afterwards, the colorimetry was measured to identify density values to take them as a reference as these values will be taken in consideration for the final test.

The color readings on the machine were carried out with a spectrophotometer on line MCCS (Mitsubishi Central Color System) with no polarizing filter, which allowed a fast and homogeneous print run checking. The density values inserted in the system are known and allow reaching the standard. Once the printing process is over and the samples dried, the colorimetry and density of solid color-were measured as for the dot gain related to screening using a spectrophotometer X-Rite 530. The settings prior to the printing, read from the color control bar located at the sheet output, were as follows:

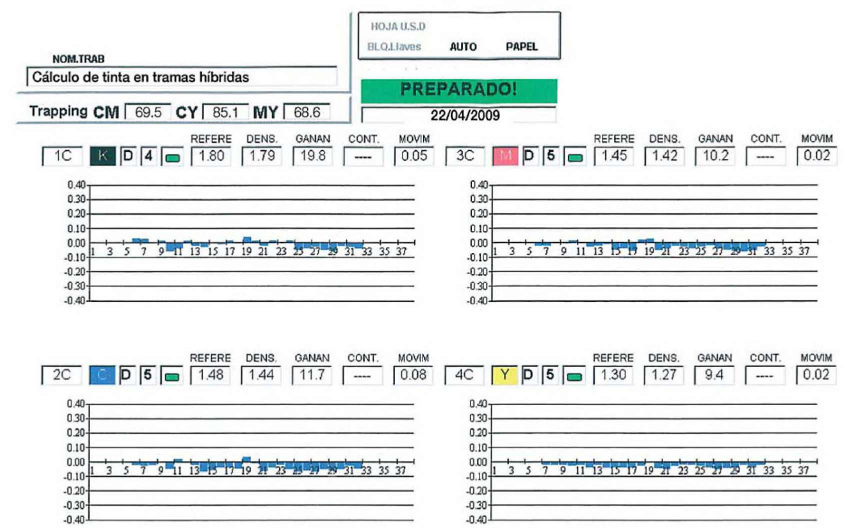

Image 3. *Machine settings from Mitsubishi Central Color System, At Orymu Graphic Arts (2009).*

The colorimetry values, with its own densities, and the dot gain measured with the spectrophotometer X-RITE 550 were as follows:

MEASUREMENTS AND GAIN CONTROL								
	C: 1,51	C: 1,49	M: 1,56	M: 1,52	Y: 1,40	Y: 1,37	K: 2,03	K:1,99
	175 lpi	XM 240	175 lpi	XM 240	175 lpi	XM 240	175 lpi	XM 240
0	0	0	0	0	0	0	0	0
5	8	12	9	11	8	12	11	13
10	17	19	15	18	17	18	20	23
20	32	34	32	34	33	33	36	38
30	46	50	44	49	45	48	51	53
40	58	63	56	64	55	63	62	66
50	68	74	69	73	68	74	72	76
60	76	83	76	82	75	82	81	86
70	84	88	85	86	84	87	87	92
80	91	95	91	95	92	95	92	97
90	97	98	97	98	96	98	97	98
95	98	99	98	99	98	100	98	99
100	100	100	100	100	100	100	100	100
L a b	54,70/-36,40/-48		46,27/72,62/-3,59		84,82/-3,74/92,68		13,34/-1,14/0,01	

Chart 5. *Colorimetry, density, and gain from the first test, At Orymu Graphic Arts (2009).*

Note: The densitometric and dot gain values on the chart are different from the ones from the MCCS. The reasons are:

- MCCS always measures without a polarization filter, but the density and dot gain values were measured with an X-RITE 530 spectrophotometer with filter as the ISO 12647-2 standard demands the measurement of the dot gain to be performed with polarization filters.
- The density values from MCCS are average values, measured in the color bar located at the output of the sheet, while the values from the chart are specifics measured with the X-RITE 530, in the test setup.
- The values of dot gain are clearly different as the standard color control bar located at the output has different line screen and is characterized.

The checking of the colorimetry against the ISO 12647-2 standard, using the spectrophotometer X-RITE 530 with polarization filter (as for the standard), was as follows:

	CYAN 1,51	**MAGENTA 1,56**	**YELLOW 1,40**	**BLACK 2,03**
Lab (12647-2)	54/-36/-49	46/72/-5	88/-6/90	16/0/0
Test Lab	54,70/-36,40/ -48	46,27/72,62/ -3,59	84,82/ -3,74/92,68	13,34/-1,14/0,01
ΔE	1.27	1.56	4.73	2.88

Chart 6. *Comparison of data against 12647-2 Standard, At Orymu Graphic Arts (2009).*

The colorimetric results were adjusted in the printing test, and, once they had fulfilled the requirements set by the standard, the density values were established for the final test.

At this point, the dot gain values should be matching the standard values: a 16% of dot gain in the 50% when using positive plate (black may be equal or 3% higher). It is easy to get a 16% of dot gain in a 175-lpi screening; the problem arises when we want to reach such a low dot gain in a 240-lpi screening: the loss of tone range would be unavoidable. That is why the dot gain in the final tests was set higher, setting it up at 19% for CMY and 22% for K, for getting a higher visual match.

e. Final test printing with the same colorimetry and gain

Having set both dot gains with the same value, the visual appearance of the screening should be the same. Once the obtained data were inserted in the RIP, the second set of plates was output and then the printing of the final test took place. The color profile adjustments in the control color bar non-linearized were as follows:

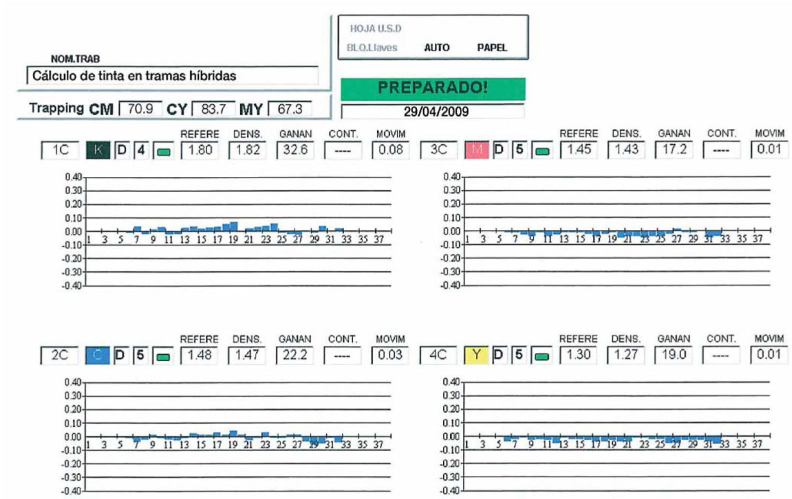

Image 4. *Machine settings from Mitsubishi Central Color System, At Orymu Graphic Arts (2009).*

After all of the previously mentioned variables were taken into account the final test commenced. The dot gain readings are shown in the following chart:

MEASUREMENT AND GAIN CONTROL								
	C: 1,55	C: 1,53	M: 1,58	M: 1,56	Y: 1,38	Y: 1,38	K: 2,04	K: 2,02
	175 lpi	XM 240	175 lpi	XM 240	175 lpi	XM 240	175 lpi	XM 240
0	0	0	0	0	0	0	0	0
5	8	10	8	9	8	9	9	10
10	14	16	13	15	14	16	17	19
20	27	31	24	26	30	31	35	35
30	42	47	37	40	45	46	47	48
40	54	60	53	53	58	58	57	61
50	66	70	65	68	68	69	70	73
60	76	80	74	75	76	78	78	81
70	81	86	80	83	83	85	82	88
80	87	91	86	91	88	90	89	91
90	95	96	92	97	94	96	94	96
95	97	98	97	99	98	99	97	99
100	100	100	100	100	100	100	100	100
L a b	53,76/-36,07/ -49,10		45,71/71,52/ -6,24		84,14/ -3,44/90,40		13,19/-2,38/ -0,97	

Chart 7. *Colorimetry, density and gain in the final test, At Orymu Graphic Arts (2009).*

f. Trim process and samples weight

Once the printing process was completed, the sheets were left to settle for four days so that the wetting water and the volatile components of the ink would not affect the weight. We verified that there was no ink setoff, and then the sheets were trimmed through a POLAR 137E precision guillotine. The printed sheets were cut with millimeter precision along with blank sheets so that test pieces were composed by sheets one above the other in a crossed way 5 from the top and 5 from the bottom and from the XM and AM screening.

Doing so, 15 test pieces were obtained from each line screen and 15 were blank, cut very precisely. Afterwards, the test pieces were weighed on a very precise Bel Engineering Mark 0.01 balance.

Results

After weighing both printed samples, the results were as follows:

Test Pieces	Blank Paper (gsm)	Sheets with 175 lpi (gsm)	XM Sheets (gsm)
1	224,49	227,80	227,00
2	224,70	227,40	227,38
3	224,81	227,65	227,12
4	224,45	227,45	227,35
5	224,64	227,70	227,10
6	224,63	227,72	227,48
7	224,74	228,11	227,35
8	224,79	227,76	227,53
9	224,95	227,81	227,60
10	224,72	227,79	227,39
11	224,73	227,72	227,50
12	224,65	227,66	227,45
13	224.63	227,72	227,36
14	224.68	227,65	227,28
15	224.78	227,52	227,31

Chart 8. *Final paper weight results,*
At Orymu Graphic Arts (2009).

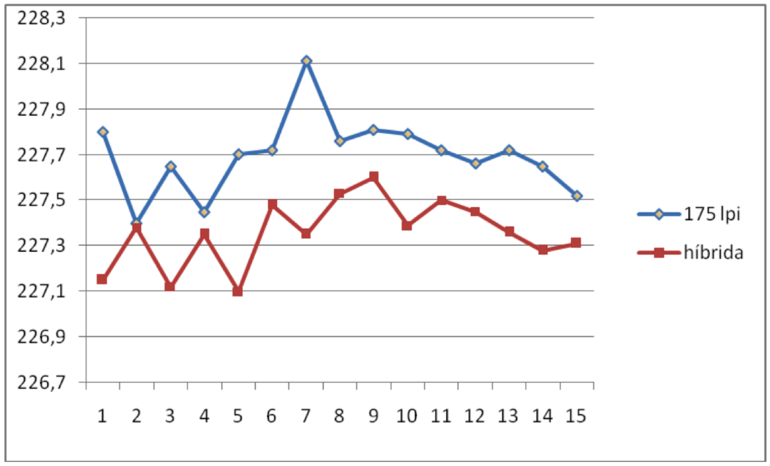

Image 5. *Final paper weight results chart,*
At Orymu Graphic Arts (2009).

The average values and the standard deviation are:

	Average (gsm)	Stand. dev.
Blank paper:	224,69	0,12
175 lpi:	227,70	0,17
Hybrid:	227,36	0,15

From this data, the ink consumed for each 10 printed sheet, using a test with this ink coverage, is:

175 Lpi. – PAPER (gsm.):	3,01
HYBRID – PAPER (gsm.):	2,67

We noticed a difference of 0.34 gsm for each 10 printed sheets in format 480×387 mm—including blank sheets placed around the image test—which means each printed test consume 0.034 gsm more.

If we extrapolate these results to different sheet formats, only 1 face printed and with similar ink coverage to the test, the results would be as follows:

Format (mm):	700×1,000	900×1,300	1,200×1,600
Saving per sheet (gsm):	0,128	0,2141	0,3514
Saving per 100,000 Sheets (kg):	12,8	21,4	35,1

Conclusions

At this stage and having analyzed carefully the data previously shown, we can come to the conclusion that a medium-size company, with a printing turnover close to 100 million of sheets per year and ink consumption estimated of 25.000 kg, implementing this kind of screening would be able to reach an ink savings near 20%.

We cannot forget that the data from this study include ink charges between the 200 and 340%, depending on images zone and maximum coverage in the sheet. If these data are applied in a real production environment, such as the color graphic edition, where the text and blank zone represent an important percentage of the printing surface, the interpolation of the values obtained in this paper should be done so that the ink savings would decrease from 5 to 10%, rating very significant in terms of economic value and competitiveness.

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Selected Bibliography

Agfa-Gevaert N.V. 2003. *Sublima: Tecnología de tramado avanzada.* Folleto de producto.

Fernández Nogales, A. 1997. *Investigación de mercados. Obtención de información.* Ed. Civitas. Madrid.

Hernández, Fernández, and Baptista. 1991. *Metodología de la investigación.* McGraw-Hill México.

Lisi, J. AND I. Baitz. 2006. "Effect of AM versus FM screening on ink consumption on a sheetfed offset lithographic press," *TAGA proceedings 2006.*